

OUTPUT PENTODE

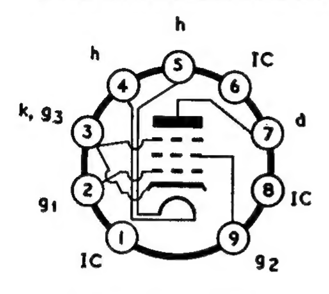
6·3 INDIRECTLY HEATED

N709

JULY, 1956

A high slope pentode primarily designed for use in the output stage of AC receivers and amplifiers.

BASE CONNECTIONS AND VALVE DIMENSIONS



View from underside of base

Base : B9A

Bulb : Tubular

Overall length : 78 max. mm.

Seated length : 71 max. mm.

Diameter : 22·2 max. mm.

HEATER

V_h	6·3	V
I_h	0·76	A

RATING

V_a		300	max.	V
V_{g2}		300	max.	V
V_{h-k}		150	max.	V
I_k		65	max.	mA
p_a		12	max.	W
p_{g2}		2·0	max.	W
μ_{g1-g2}	at $V_a=V_{g2}=250$	19		
r_a	$V_{g1}=-7·3$	38		kΩ
g_m	$I_a=48mA$	11·3		mA/V

TYPICAL OPERATION

Single Valve. Class A. Audio Amplifier.

V_a	250	V
V_{g2}	250	V
V_{g1}	—7·5 approx.	V
I_a	48	mA
I_{g2}	5·5	mA
$V_{in}(pk)$	6·5	V
R_a	5	kΩ
P_{out}	6·0	W
D	10	%

CAPACITANCES

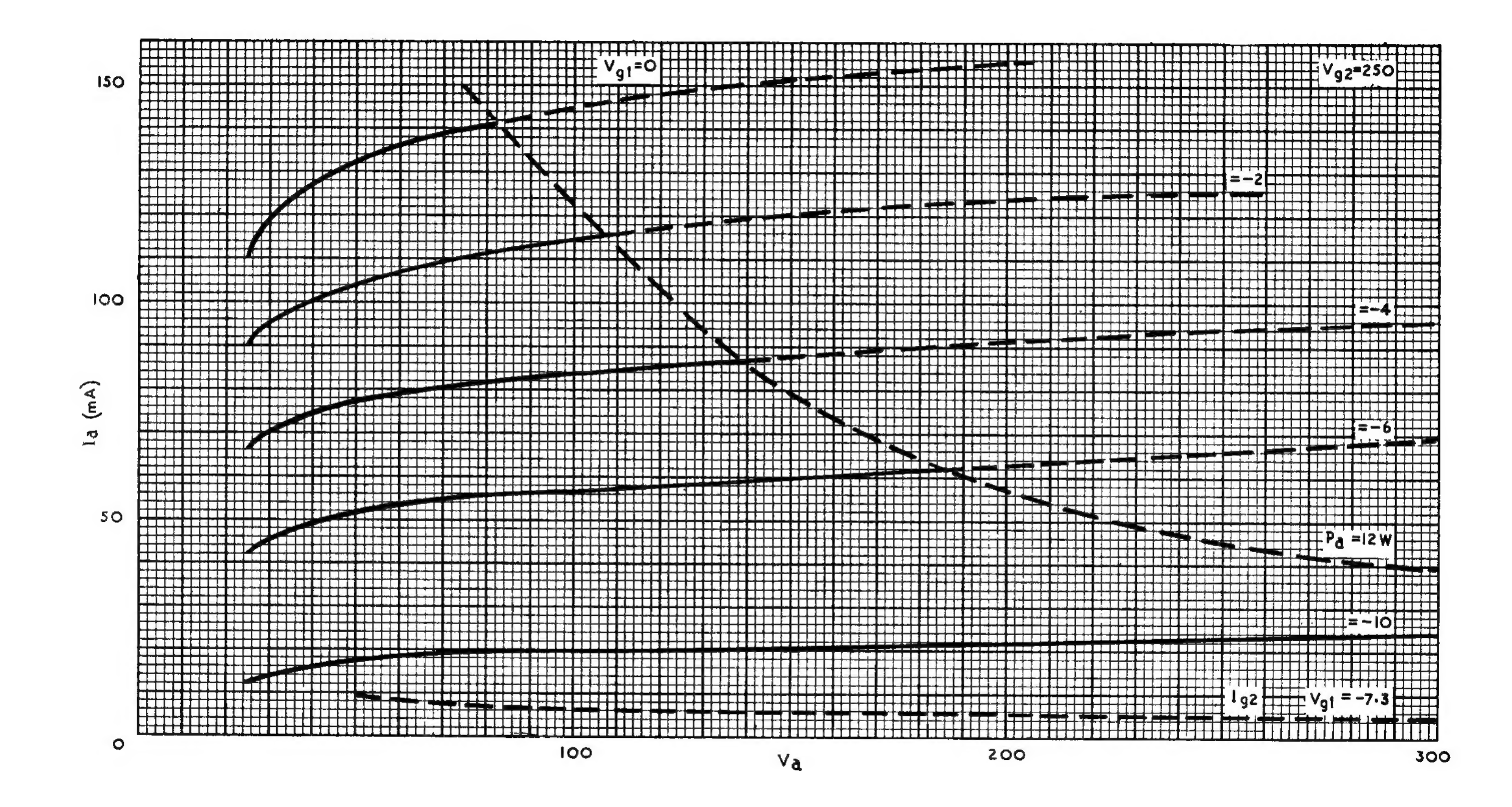
c_{in}	11 pF	c_{a-g1}	$\not>$0·5 pF
c_{out}	6 pF	c_{g1-h}	$\not>$0·25 pF

VENTILATION

Free air circulation round the bulb is preferable. The temperature of the hottest part of the bulb must not exceed 250° C.

MOUNTING

Any position.



V_{g1}=0
V_{g2}=250
=−2
=−4
=−6
P_a =12 W
=−10
I_{g2}
V_{g1} = −7·3
150
100
50
0
I_a (mA)
100
200
300
V_a



CIRCUIT SUPPLEMENT

N709

JUNE, 1956
SECOND EDITION

N709 ULTRA-LINEAR AMPLIFIER

The full circuit diagram is shown in fig. 1, where two N709 valves are preceded by a pair of Z729 valves to form an amplifier having a basic sensitivity rather better than 50 mV for full output. Approximately 10 db feedback has been added, resulting in an input requirement of 150 mV.

As shown, the output valves are connected in the " ultra linear " circuit which provides a lower distortion and output impedance than the normal pentode arrangement together with a higher power output than triode connected valves. With the addition of a small amount of degeneration the distortion at 10W is below 0·1%.

The circuit requires little explanation. The use of a Z729 in the first stage ensures complete freedom from unwanted hum and microphony. The valve is internally screened and no external can is required but one may be added to act as a retainer if desired. A second Z729 is used in the phase-splitting stage but, alternatively, a DH77 may be used with diodes earthed ; in this case the values of R5, R6 and R7 should be doubled.

The output transformer primary is tapped at 20% of the turns on each half-winding for the screen supply. An extremely low order of leakage inductance between primary and secondary is not necessary as the overall feedback is only about 10 db, but this may be increased optionally. The degree of feedback is determined by the resistors R15 and R16. Assuming R15 has a value of 22Ω, the value of R16 is given by $650\sqrt{Z_s}$ where Z_s is the loudspeaker speech coil impedance. The nearest standard values may be used and close tolerance resistors are not required.

The ratio of the output transformer is given by $\sqrt{R_L/Z_s}$ where R_L is the specified anode to anode load. According to the operating conditions the optimum load varies from 6 kΩ to 7 kΩ. However, 7 kΩ is a good compromise and a satisfactory performance will be obtained with a transformer providing this impedance. The recommended type will therefore have a ratio of 21·5 : 1 for a 15Ω loudspeaker. If the secondary is wound in two halves, either a 15Ω or 3·5-4Ω loudspeaker may be used by a series or parallel arrangement of the windings. Each half-primary should have a tapping point at 20% of the turns measured from the centre for the screen grid connection.

The capacitors, C11 C12, are usually necessary to prevent parasitic oscillation with the ultra linear circuit and should not be omitted, although the value is not critical. The same applies to the grid and screen resistors, R10, R11, R12, R13.

ULTRA LINEAR OPERATION (See figs. 2 and 3)

Data per pair unless otherwise indicated.

$V_{a(b)}$	315	V
$V_{a,g2}$	300	V
$I_{a+g2\ (o)}$	88	mA
$I_{a+g2\ (max.\ sig.)}$	100	mA
R_k (per valve)	270	Ω
V_k	13	V
$p_{a+g2\ (o)}$	13	W
$p_{a+g2\ (max.\ sig.)}$	8	W
P_{out}	14	W
*D_{tot}	1	%
$R_{L\ (a-a)}$	7	kΩ
$V_{in\ (g1-g1)}$ (rms)	18	V
*Z_{out}	9	kΩ

* Basic circuit without feedback.

With resistors R15 R16 added, the following data is obtainable (Curve B, fig 3).

D_{tot}	0·1	0·25	0·5	%
P_{out}	11	12	13·5	W
Z_{out}		1800		Ω
V_{in} to Z729 (rms)		150		mV

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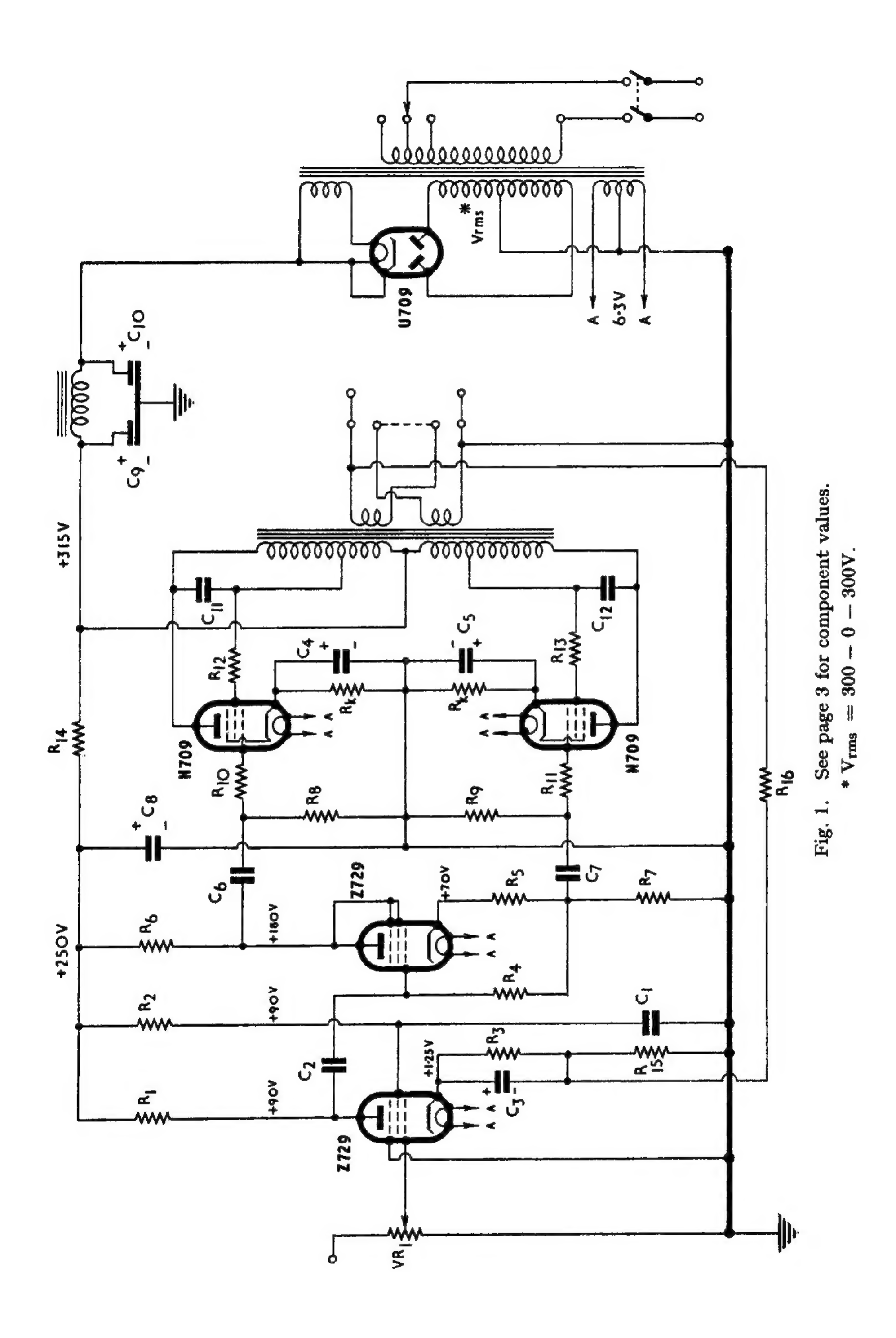


Fig. 1. See page 3 for component values.
* V_{rms} = 300 — 0 — 300V.

COMPONENT VALUES

RESISTORS

(0·25W, 20% unless otherwise indicated)

R1	220 kΩ		10%
R2	1 MΩ		10%
R3	2·2 kΩ		
R4	1 MΩ		
R5	1 kΩ		
R6	33 kΩ	0·5W } Matched to	
R7	33 kΩ	0·5W } 5%	
R8	220 kΩ		10%
R9	220 kΩ		10%
R10	10 kΩ		
R11	10 kΩ		
R12	100 Ω		
R13	100 Ω		
R14	15 kΩ	0·5W	10%
R15	22 Ω		10%
R16	1·5 or 2·7 kΩ for Z_s equal to 4 or 15 Ω respectively.		
R_k	270 Ω	0·5W	5%
VR1	0·5 MΩ (or higher) variable.		

CAPACITORS

C1	0·1 μF	Paper	
C2	0·01 μF	Paper	
C3	50 μF	Electrolytic	12V
C4	50 μF	Electrolytic	25V
C5	50 μF	Electrolytic	25V
C6	0·05 μF	Paper	
C7	0·05 μF	Paper	
C8	8 μF	Electrolytic	350V
C9	16 μF	Electrolytic	450V
C10	16 μF	Electrolytic	450V
C11	0·001 μF	Paper or Mica	
C12	0·001 μF	Paper or Mica	

L1 — Smoothing Choke : 10-20H 100 Ω

T1 — Output transformer : 21·5 : 1 or 43 : 1. Primaries to be tapped at 20% of turns in each half.

T2 — Mains transformer :
Secondary : 6·3V, 3A
6·3V, 1A
300 — 0 — 300V 120mA

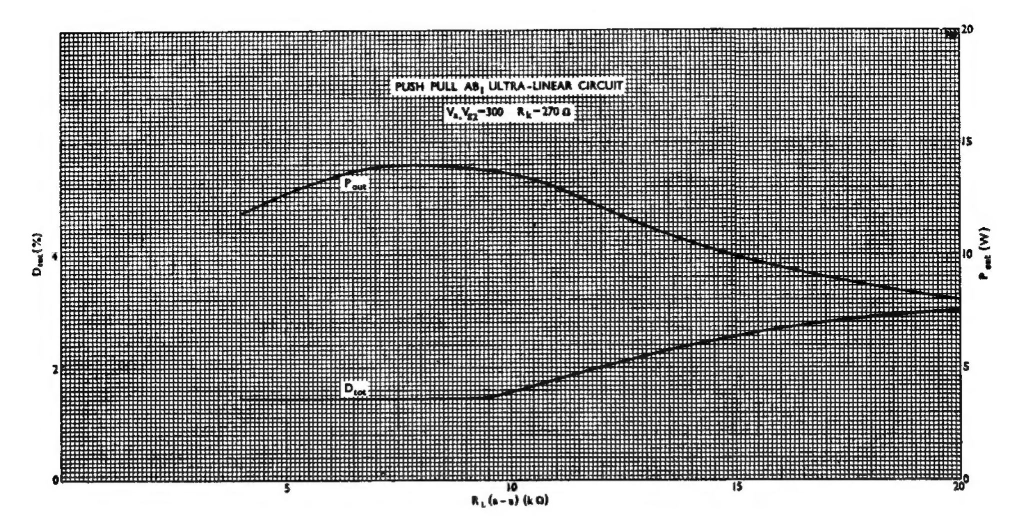


Fig. 2.

PUSH PULL ULTRA-LINEAR CIRCUIT

CURVE A $V_a, V_{g2} = 300$ $R_k = 270\,\Omega$ $R_L = 7000\,\Omega$
B AS ABOVE BUT WITH DEGENERATION 10 db

A

B

D_{tot} (%): 0, 0·5, 1, 1·5, 2

P_{out} (W): 0, 2, 4, 6, 8, 10, 12, 14

Fig. 3.